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## **FIRE INVESTIGATION, ARSON CRIMINALITY**

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### **ABSTRACT**

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Detecting the causes of fires is one of the major and complex technical disciplines in the context of activities related to the Fire Protection Department. The fulfilment of this task cannot be understood in a static way, but rather as a constantly evolving process where it is absolutely necessary to use the results of science and technology and to apply the new knowledge effectively in practice.

Arson is a very costly, socially dangerous problem. The amount of fire damage in 2015 was in the Slovak Republic, with the statistically reported average number of exits to fires over the last 10 years reaching 11500. In 2015, it was 11317 fires, which were intercepted by fire and fire brigade firefighters. Most fires have arisen from the carelessness and neglect of adults, which caused up to 53% of all fires last year. The second most significant group of causes of fires is of utmost interest from the point of view of the causes of fires. The share of deliberate fires was 13% in 2015, i.e. 1471 fires. An additional 10% of fires originated from unknown causes.

The paper deals with fire investigation procedures and focus on procedures of sample collecting with use of arson dogs or alternative technic sample equipment.

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## INTRODUCTION

An important component in terms of threats to persons and property is the fire of passenger cars. In 2015, 815 fires were reported, resulting in 10 people being killed and 16 injured. Property damage amounted to € 3,644,525. Similarly, in the neighboring Czech Republic, intentional fires represent a major part of the fire of passenger cars, with a share of 29% in 2015 and direct damage of several billion crowns per year<sup>1</sup>. Arson, the deliberate and malicious burning of assets, accounts for roughly a fifth of these costs.

The most effective way to reduce costs and damage caused by arson is by means of an effective fire investigation that would lead to the detection and prosecution of the person responsible. Fire investigation is a field of forensic science that focuses on determining the origin and causes of a fire. Determining the origin of the fire answers the question „Where did the fire begin?“ The determination of the cause of the fire answers the question „Why did the fire begin?“ As with all forensic disciplines, the use of science in the field of fire investigation is developing very rapidly. Progress in improving technologies, equipment, training and education positively affects the way in which a forensic or fire laboratory can assist the investigator in determining the origin and cause of the fire.

The main objective of chemical expertise of fire samples is to determine whether there are substances (accelerants) present in these samples that could help to create a fire or accelerate its spread. We might think that a highly volatile substance, such as gasoline, should be totally aggravated and should leave no trace of it (the usual flagship expectation). However, traces of fire accelerants, i.e. Furnace accelerators often remain present even after a fiery fire. When the flammable liquid is spilled on porous material such as carpets or upholstery, it swells to the depth of the material very quickly. After ignition of the fire, combustion occurs only on the surface where oxygen is available, so that the fluids from the surface evaporate and burn, while the liquid absorbed in the deeper layers of material remains intact. In the case of a fire that is sufficiently quickly extinguished, or in cases where the conditions for burning (oxygen deficiency) are not suitable, the combustible liquid used by the flares

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<sup>1</sup> Prezidium HaZZ, MVSR, Požiarne štatistiky 2015, online.

may not be completely burnt. In such cases, a subsequent chemical analysis of fire materials can tell us what type of liquid has been used.

Successful detection of the causes of fires is and will always depend on the ever-increasing information on new knowledge not only from the fire department but also from other fields such as construction, chemistry, electrical engineering and the like. The overall results are significantly influenced by the individual approach, the specialization of the member in the given issue, the degree of experience gained, the knowledge of fire prevention and repression, as well as other related disciplines of forensic discipline. Requirements for detecting causes of fires are constantly increasing. An employee dealing with this profession must be an equivalent professional partner of the law enforcement authorities.

The general characteristics of the detection of the causes of the fire have been gradually grounded in the system of professional firefighters in Czechoslovakia since 1960. The first investigators are among the employees of the prevention department. In the districts, fire inspections took place. The activities of the investigators are gradually specified and the first separate departments within the Prevention Departments are established.

The Fire Examiner focuses on identifying the primary cause of the fire. This is its core business. Its findings then serve the needs of the police authorities, which determine further procedures, possible prosecution or cessation of the case. Another activity of the investigator is the execution of state fire surveillance, i.e. control of compliance with regulations and regulations in connection with fire protection.

The detection of the causes of the fire is mainly focused on determining the specific cause of the fire. This is important for prosecuting authorities (possible prosecution of a criminal or negligent act), for insurance companies (information on claims) as well as for prevention (e.g. fire prevention in certain types of operations or objects). The competence of the HaZZ (Fire Rescue System) to determine the causes of fires is laid down by the Fire Protection Act<sup>2</sup>, the Decree of the Ministry of the Interior and the orders of the President of HaZZ<sup>3</sup>. The Law about Police is also related to the Fire investigator work<sup>4</sup>.

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<sup>2</sup> Law 314/2001 about fire protection, art. 7.

<sup>3</sup> Decree of MV SR 121/2002 about fire prevention.

<sup>4</sup> Law 353/1997 about Police

## FIRE INVESTIGATION

A fire investigation as well as fire risk assessment includes the identification, analysis and evaluation of indicators in a suspected fire. Detecting the causes of fires is a highly professional activity aimed at detecting the causes of the fires, the reasons and the ways of their spread and the damage caused. It includes statistics that are linked to the knowledge about specific causes used to create standards for fire protection. Based on the determination of the cause of the fire, the legal responsibility of the particular persons for the occurrence of the fire is derived. The work requires practical knowledge of criminalistics methods and procedures.

The Fire Cause Detector is a person with the required professional competence and knowledge as instructed by the District or Regional Director of HaZZ. He must have extensive knowledge of fire prevention, fire dynamics, chemistry, self-ignition processes and the necessary foundations of many leading disciplines<sup>5</sup>. Basic knowledge of forensic science is also required. We distinguish the basic three levels of fire causes. Level 1 is the first man to hit the fire. Level 2 is a fire detector with some special training (training). Level 3 is a firefighter with specific experience and expert knowledge.<sup>6</sup>

## POINT OF ORIGIN

By the term “criminalistic point of origin” we mean every place where burning has started and where the source of fire must also be found. It is the place where the perpetrator, for example, lit a stack of hay. It is not decisive whether the perpetrator caused it deliberately or negligently (e.g. a forgotten iron, etc.). Criminalistic point of origin is usually found only one. However, there may be a case where two or more fires are detected. Such a finding makes it possible to say unequivocally that it is intentional ignition. The main purpose of a fire survey is to find a crime scene, where the burning has started, and resources, from which the fire has spread to other objects and spaces. Instead of a crime scene, there should be traces that would clearly indicate that this place was a real source of fire<sup>7</sup>.

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<sup>5</sup> V. Banasinský, *Zjišťování příčin požárů*, Ostrava 1995, VŠB FH-G 1995, p. 37–39.

<sup>6</sup> European Network of Forensic Science Institutes, 2016, ENFSI guideline for evaluative reporting in forensic science, 2016, online, p. 33.

<sup>7</sup> P. Pokojný, *Zisťovanie príčin vzniku požiarov*, Bratislava 1975, ALFA, 93 p.

### WITNESS POINT OF ORIGIN

Witnesses are often referred to as the focal point. As this point is usually referred to as the place where the fire first appeared, the fire manifested itself by either a large occurrence of smoke or flames. These focuses are most often detected when interviewing witnesses. However, this outbreak is not usually the same as the criminalistics point of origin, but even if we cannot completely exclude such a consensus.

### FIREFIGHTERS POINT OF ORIGIN

Firefighting point of origin is the place where firefighters saw the most intense burning, and they also paid the greatest attention when locating a fire. In most cases, it is the place where most flammable substances have been stored. Firefighting point of origin is the place mostly hit by fire (melting of materials, various deformations, etc.). This place may or may not be the same as a crime scene. The actual outbreak of war crimes, on the other hand, may not be seriously damaged, because the fire could spread through various scattered flammable materials (handrails, spider-webs, papers, etc.).

FIG. 1. ARSON DOG DETECTING THE ACCELERANT



### **FIRE INVESTIGATOR PROCEDURES**

The early detection of a detector at a fire site allows important traces to be destroyed, which may be destroyed by the further development of the fire and the operation of the interfering units. It allows him to capture the situation on the site of a fire that can subsequently be altered as a result of a developing fire by activity during rescue, localization and liquidation work. Tracking the dynamics of the fire, recording the different traits of burning, and tracking the progress and effectiveness of the firefighting, provides him with a wealth of information that he would later acquire with difficulty or not at all. Personal fire monitoring gains a general overview and orientation on a fire. In case of its arrival after the fire is destroyed, it is possible to obtain this data from the intervening units and witnesses. The meteorological station may specify the meteorological situation.

Recording of activities during extinguishing and rescue upon arrival to the fire site, important information should be noted such as:

- a) persons present at the site of the fire (witnesses, owners, residents and others) and to monitor their suspicious behavior,
- b) the meteorological situation (wind direction and force, visibility, etc.),
- c) evaluate safety, evacuation of persons and focus on localization of fire,
- d) the arrival of the owners and their response upon receipt of the fire report,
- e) the number and type of fire engines and the fire brigade.

### **RECORDING THE FIRE SPACE**

Investigator makes the photos and their documentation to see the completeness of the fire site as soon as possible. This should include all the angles and views of the site, including those parts that may not have been affected by a fire at that time. Photographs of firefighting activities will be made, with particular regard to the area of the seizures and flames at the time of the fire. It is also useful to record a fire using video cameras. Ensures date and video timing.

### **MINIMIZE CHANGES IN FIRE AREA**

For each subsequent investigation, it is important not to move anything in the fire area unless this is necessary. Since it is known that some objects move and damage during the fire-fighting activity, their relocation from the fire area must be minimized, then photographed and written. Any

change to a fire before the detector's arrival of the cause of the fire must be recorded and properly documented.

#### **MODERN APPROACHES TO ACCELERATOR DETECTION**

##### **ACCELERATOR DETECTION BY ARSON DOG**

Method of detection of flammable substances, accelerators of fire using police dogs is a method of criminological tactics. This method is used to detect flammable substances in a deliberate fire. Police dogs are able to search for flammable substances, fire accelerators that remain after extinguishing fire at the site of fire in the form of residues. With this method, very small residues of these substances can also be detected in the burned residues in the fire and in the contaminated garbage cloth. The basis of the training methodology was taken over from the USA and transformed into European and Slovak conditions.

##### **ACCELERATOR DETECTION**

Accelerators are highly flammable substances that evaporate often at temperatures below 0°C. These are mostly substances based on petroleum products. The most commonly used accelerators include: Automotive gasoline, diesel, kerosene, various types of diluents, coatings, adhesives, acetone, alcohol, toluene, etc. Because of their flammability they are very often used to accelerate the spread of fire.

During fire, the temperature in the focus rises up to 2000°C. At these temperatures, residual fluids remain on the burned remains, which cannot be detected by the man's smell at the site of the fire and, in most cases, no technical means.

At the markings of the service dog, the expert secures specimens of accelerator carriers to chemical cans, which are sent to a specialized chemical analysis workplace.

Whether localized and identified accelerators are related to the cause of a fire or not is assessed by the designated police authorities.

Arson dogs are used to detect:<sup>8</sup>

- Screening of residues of flammable substances on fire,
- Operational verification of people near the fire.

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<sup>8</sup> Edict of MV SR 15/2004 about kinologic service.



It can be used for the operational verification of people near the fire. Persons suffering from some of the mental illnesses (pyromania) or sexual abduction (pyrophilia), after fire, usually remain in place and observe fire-fighting. The handler in civilian clothing walks with the dog in the crowd. In the case of a positive tag, the person can be perforated and handed over to the examining body.

In order to identify a contaminated person with a flammable substance when the person is held in custody on the basis of other facts (the dog is able to mark the remnants, for example: automobile gasoline on the hands even after multiple washing).

Checking of the objects of the perpetrators or suspects, luggage, tools, detained persons before demonstrations, investigation of the fire environment, etc. Browse people before entering the protected area, in home inspections in cases of illicit manufacture of certain drugs (toluene and acetone in the production of pervitin).

The advantage of the use of service dogs is the high selectivity and sensitivity of the dog's foulness, which is also able to record the ultra-high velocity of accelerators of very complex matrices at the site of the fire (smoke composed of the incomplete combustion of wood, plastics, chemicals, etc.).

The arson dog is able to perform a quick inspection of a large fire and very accurately locate all the locations of the rest of the fire accelerators. Its capability is universal, it is able to identify trace amounts of accelerators that are physically bound in pores of burnt wood, soaked in fibres of textile materials, earth, plastics, water, leather and other carriers.

The disadvantage of these dogs is the limited use by the number of these dogs, furthermore the limited gut ability (they only react to fourteen kinds of doors).

#### **ODOR DETECTOR**

In the UK, firefighters investigate the so-called "fuel odor detector" at the site of a fire. This is a hydrocarbon vapor detector that sucks in the air and delivers it to a hydrogen flame (Fig.2). A higher flame temperature indicates the presence of accelerants. The procedure for searching and securing additional tracks is basically the same as ours. Once the focus of the fire is localized, the investigators shuffle the ruin to find the source of the fire. Basic artillery tools are accelerators such as gasoline to ensure

that the fire develops quickly, and incendiary devices to ignite it. This can be very complicated, for example an electronic timer or, conversely, very simple, as the ignited cigarette inserted into the match box. The traces of such accelerators and incendiary devices surprisingly often survive the fire they founded.

FIG. 2. HYDROCARBON GAS DETECTOR



You do not have to be an expert to get suspicious of arson. The unpleasant hydrocarbon fuels and solvents remain a characteristic odor. Flammable liquids leave visible traces such as sharp edges of irregular stains on the floor. It can also be typical burnt patterns on the edges of the floorboards, which indicate that the burning liquid was flowing between them. If none of these tracks are present, the investigators use special smoke detectors to identify the remains of the accelerators. When they find anything suspicious, they take the contaminated object for laboratory analysis<sup>9</sup>.

Experiences from the United States shows that the results of using service dogs to search for burners are not one-hundred percent. It is reported that the amount of mistakes is about 3–5% of the total number of samples taken, even in the top-trained dogs. These errors are due to the fact that the sensitivity of the dog's stomach system is higher than the sensitivity

<sup>9</sup> NFPA1033 Standard for Professional Qualifications for Fire Investigator, 2014, p. 118, online.

of commonly used analytical instruments, and also by the fact that burning of some materials such as polystyrenes, foam rubbers and the like results in smells similar to the odor of the accelerators.

#### **EARLY DETECTION**

The early detection of a detector at a fire site allows important traces to be destroyed, which may be destroyed by the further development of the fire and the operation of the interfering units. It allows him to capture the situation on the site of a fire that can subsequently be altered as a result of a developing fire by activity during rescue, localization and liquidation work. Tracking the dynamics of the fire, recording the different traits of burning, and tracking the progress and effectiveness of the firefighting, provides him with a wealth of information that he would later acquire with difficulty or not at all. Personal fire monitoring gains a general overview and orientation on a fire. In case of its arrival after the fire is destroyed, it is possible to obtain this data from the intervening units and witnesses. The meteorological station may specify the meteorological situation.

#### **RECORDING OF ACTIVITIES DURING EXTINGUISHING AND RESCUE**

Upon arrival to the fire site, important information should be noted such as:<sup>10</sup>

- a) people present at the site of the fire (witnesses, owners, residents and others) and to monitor their suspicious behavior,
- b) the meteorological situation (wind direction and force, visibility, etc.)
- c) evaluate safety, evacuation of persons and focus on localization of fire,
- d) the arrival of the owners and their response upon receipt of the fire report,
- e) the number and type of fire engines and the fire brigade.

#### **RECORDING THE FIRE SPACE**

Make photos and their documentation to see the completeness of the fire site as soon as possible. This should include all the angles and views of the site, including those parts that may not have been affected by a fire at that time. Photographs of firefighting activities will be made, with particular regard to the area of the seizures and flames at the time of the fire. It is also useful to record a fire using video cameras. Ensures date and video timing.

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<sup>10</sup> European network of forensic science institutes: fire and explosion investigation working group, PTEÚ MV SR, 2015.

FIG. 3. FIRE/ARSON INVESTIGATOR



#### MINIMIZE CHANGES IN FIRE AREA

For each subsequent investigation, it is important not to move anything in the fire area unless this is necessary. Since it is known that some objects move and damage during the fire-fighting activity, their relocation from the fire area must be minimized, then photographed and written. Any change to a fire before the detector's arrival of the cause of the fire must be recorded and properly documented.

#### SAMPLE COLLECTION

An important activity of the investigator is also the taking of a sample of evidence for the assessment of the fire-technical, safety and other required characteristics. All specimens and evidence should be properly documented and noted should be where they were taken. It is most appropriate to prepare a sketch or drawing in which the sample taking place is marked. Each material has its case number and it is marked in the fireworks sketch.

The accompanying documentation to be sent together with the samples taken for the expertise consists of:

- a) a protocol on sampling and other evidence,
- b) photographic documentation with an indicative firefighting plan and sampling photographs (the point of departure shall be indicated by an arrow) (Fig. 2),

- c) technical documentation,
- d) a description of the situation at the time of the fire at the fire.

#### SOLID SAMPLES COLLECTION

When collecting compact or flat materials together with burnt and abrasive residues, it is necessary to proceed so that the sample contains both the damaged (damaged) and damaged (burned or hardened) part. The size of the samples is 0.2–0.5 m<sup>2</sup> for flat materials and the lengths of these samples should not exceed 800 mm. Samples are packaged in polyethylene bags, which must be properly sealed. When grain or powder masses are taken, the samples must represent both the original and the fire damaged mass. The method of sampling is selected according to the specific conditions of the fire. The weight of the sample should be between 0.1–1.0 kg and stored in a wide-necked bottle with a screw or countersunk plug or polyethylene bags to ensure air-tightness<sup>11</sup>.

FIG. 4. TRAINING FIRE INVESTIGATION SITE WITH THE KITCHEN



<sup>11</sup> The Fire Protection Research Foundation, 2002: The Preliminary Scene Assessment: A Checklist, Online.

### **LIQUID SAMPLES COLLECTION**

When taking samples of liquids, care should be taken when all safety precautions are taken. When collecting samples from larger containers, cisterns or drums, it is necessary to ensure that the average sample is removed. When removing mixtures of non-immiscible liquids or solids, the mixtures must be mixed before sampling. When sampling it is necessary to ensure that the liquid is not additionally contaminated with other substances. Samples are taken into clean and dry glass bottles with a spherical or tight sealing screw in a volume of 500–1000 ml.

### **SAMPLING OF GASEOUS SAMPLES**

When collecting gas samples, it is necessary to identify the type of gas and use appropriate protective equipment. Gases are removed using a rubber or plastic blower into clean gas samples and the gas volume should be about 1000 ml. the sample box must be flushed with at least three times the volume of the withdrawn gas before closing. The sample boxes must be properly sealed.

### **COLLECTION OF ELECTRO-TECHNIC MATERIALS**

When securing electro-technic materials, we do not separate them if we do not remove the conductor in the installation pipe. Conductors of one meter length do not bend when transporting, if the conductor is longer, gently bends at the point of smallest damage. The direction towards the appliance and the source is indicated.

### **EMERGENCY SAMPLING BY FIREFIGHTERS**

In Germany, is done exactly according to the frame conditions of the intervention. “Emergency Samples” taken by firefighters serve to support defense against dangers and fix the found true state for current detection with more costly analytical procedures. These fire brigades are available through concepts of sampling and analysis of hazardous substances covering the territory of recognized professional institutions. They relate to their corresponding regulations.

“Emergency Samples” are required to collect and analyze dangerous substances under investigation using suitable and timely available technical devices. Not intended for competent authorities, or police investigation. But since firefighters come to the scene most often than the first,

the police and expert authorities are interested in samples from the initial phase of the event in order to be able to estimate the hazards and take further action. Emergency samples may be provided by fire brigade to specialist authorities for further use. Here, it is important that firefighters thoroughly document the framework conditions for sampling.

Safety indicators and substance data. The following safety indicators and substance data can draw attention to the threat and point to tactical intervention measures when known substances are present and the necessary data can be found in the background and databases or through external sources of information. The table provides just explanations close to the practice. Exact definitions can be found in the relevant standards and firefighting literature.

The fitting of suitable devices is always based on the particularities arising from the position, properties of the substances present as well as personal and technical possibilities. Possible applications of fire measuring devices are divided into three types of threat:

- A) Atomic hazards (ionizing radiation of radioactive substances),
- B) Biological hazards (hazards of infection),
- C) Chemical hazards (including fires).

The necessity of sampling and sampling for fires depends on the particularities of the substances involved in the fire, the duration and spatial spread of the fire. Smoke from the fire is believed to be fundamentally harmful to health and therefore contact with smoke should be avoided. Typical active substances of fire smoke are known from scientific research. Only in special situations the fire detection procedures provide tactical data that can be used in the intervention.

Fire-fighters are protected against respiratory protective devices, depending on the environment. In the immediate area of fire, two hours after the extinction of the fire with protective masks is to work. The affected person may be provided with a note on the note.

## CONCLUSION

Fire investigation has an irreplaceable role in fire prevention. With regard to the data and information that is detected during fire investigations and subsequently analyzed, it is possible to eliminate negative trends related to the occurrence of fires and their spread. The results are used as a basis for proposals for regulatory measures, in the form of legal regulations, are

also used to identify problematic areas for the performance of control activities and, last but not least, for preventive educational activities.

Some negative phenomena in the investigation of fires are manifested in cooperation with the Police of the Slovak republic, as the two administrative authorities fulfill their duties at one point and have different competences. The synergy of both components is covered by a framework agreement. Fire investigation is a highly erudite activity. Each investigator has to know a great deal of regulations and at the same time must be able to determine the cause of fires, which is the work of the criminalist. There are many useful abilities. Fire investigator should use the service arson dog and electronic detectors of chemical traces. It is therefore necessary to create conditions for adequate training of these members, in particular to create conditions for practical training.

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